

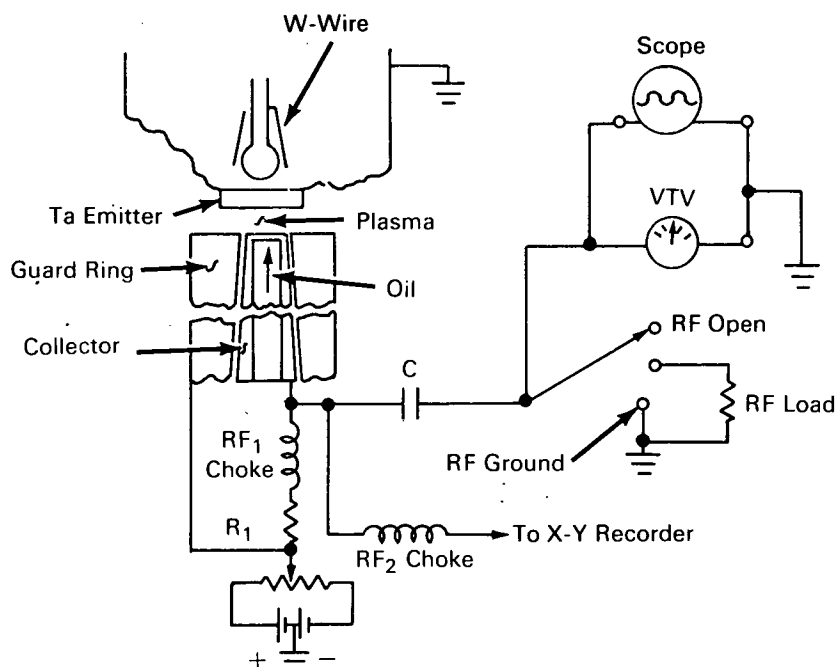


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Potassium Plasma Cell Facilitates Thermionic Energy Conversion Process



The problem:

To devise an economical and efficient method of converting nuclear energy into electrical power. The concept of thermionic energy conversion has shown promise as a direct means of employing nuclear energy, but it has not yet been reduced to practice. In present methods, reactor heat is converted to steam to drive steam turbine power generators which produce the electrical power. The generators and associated equipment are too bulky for some specialized uses.

The solution:

A thermionic energy converter, consisting of a potassium plasma cell, a tantalum emitter, and a

silver plated copper collector, which converts nuclear generated heat directly into high frequency and direct current output. This conversion process eliminates the steam interface usually required between the atomic heat source and the electrical conversion system. The process also eliminates the bulky steam equipment.

How it's done:

In the thermionic conversion process, a heated source such as tantalum emits electrons. Some electrons are received at a collector and can be utilized as dc current; the electrons in transit create a negative space charge, which must be neutralized by positive

(continued overleaf)

ions such as those of potassium, before the space charge reaches a voltage potential which could cut off the electron flow. This neutralization often produces radio frequency oscillations, which must be removed or separated for effective utilization of the dc current.

The experimental arrangement shown was used to measure the radio frequencies, rms voltages, power output and other quantities under various conditions of emitter temperature, potassium vapor pressure, dc and rf loads.

The thermionic converter arrangement consisted of a 1/2-inch-diameter tantalum button as an electron emitter which was heated by an electron gun, and a 1/4-inch-diameter silver-oxide collector surrounded by a guard ring. The emitter-collector distance was 2.2 mm. The emitter was on ground potential and a voltage continuously varying from -3 to +6 volts was applied to the collector and guard ring. The potassium vapor pressure was regulated by the temperature control of a trap filled with liquid potassium.

An X-Y recorder traced the dc current-voltage characteristic. The rf component was separated from the dc by a $2\mu\text{f}$ capacitance and connected to an rms voltmeter and oscilloscope. Chokes between the collector and the applied dc voltage excluded the rf signals from the recorder.

The dc characteristics were taken for a constant emitter temperature and vapor pressure with the rf open and the rf short-circuited. For each characteristic, the radio frequency decreased with decreasing voltage applied to the collector, and decreased with increasing emitter-collector spacing. For any increase

in emitter temperature and current, the radio frequencies decreased for identical collector dc voltages. Rf oscillations do not occur for potassium ion densities much greater than electron densities, as e.g., 10^{-2} mm Hg. These observations agreed with theoretical computations.

Notes:

1. Additional details are contained in *AMU-ANL Conference on Direct Energy Conversion*, November 4-5, 1963, Argonne National Laboratory (ANL) Report No. 6802, pp. 152-160. This report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price \$3.00; microfiche \$0.65.
2. Inquiries concerning this innovation may be directed to:

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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